PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :
B32B 3/28, 27/08

A1

(11) International Publication Number: WO 94/05489

(43) International Publication Date: 17 March 1994 (17.03.94)

(21) International Application Number: PCT/CA92/00385

(22) International Filing Date: 8 September 1992 (08.09.92)

(60) Parent Application or Grant
(63) Related by Continuation
US 708,223 (CIP)
Filed on 31 May 1991 (31.05.91)

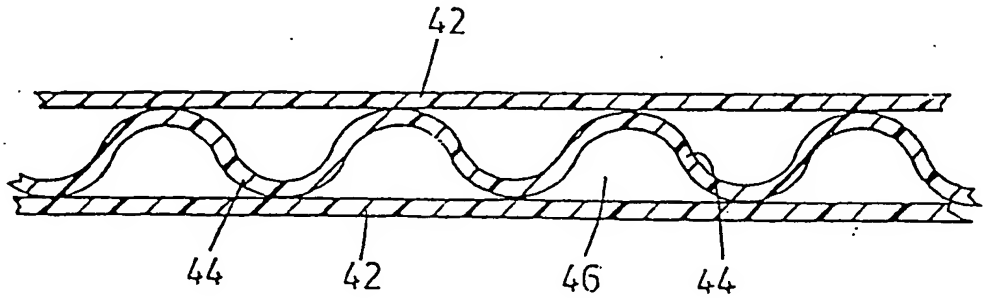
(71) (72) Applicant and Inventor: McGRATH, Stephen, Edward [CA/CA]; 3520 Pharmacy Avenue # 7, Scarborough, Ontario M1W 2T8 (CA).

(74) Agent: PARSONS, Jane; Jane Parsons & Associates, Suite 706, 43 Eglinton Ave. East, Toronto, Ontario M4P 1A2 (CA).

(81) Designated States: BB, BG, BR, CS, FI, HU, JP, KP, KR, LK, MG, MN, MW, NO, PL, RO, RU, SD, SE, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, SN, TD, TG).

Published
With international search report.

(54) Title: MULTILAYER THERMOPLASTIC SHEET



(57) Abstract

Thermoplastics material corrugated sheet (44) is provided having two outer layers (42) sandwiching an inner structure (44), the mass of which is substantially evenly distributed between the outer layers. The sandwiching or laminating process is conveniently carried out from three separate extruders providing a vertical fall of layers which are laminated by the use of at least some of heat pressure, and chill rollers against the vertical layers. On pressing the two outer layers together the inner structure crumples so that it is evenly distributed between the layers and does not form separate lumps which tend to hold the outer layers apart. When the layers have been pressed together they may be heat sealed to close channels (46) between the layers.

MULTILAYER THERMOPLASTIC SHEET

TECHNICAL FIELD

This invention relates to multi layer thermoplastic sheet.

BACKGROUND ART

Corrugated liner board is a well known corrugated paper product for packing sheet having insulating and strength properties. Boxes are frequently made from this product since the two outer layers of paper or paperboard united by a corrugated paper inner layer provide a structure of increased rigidity in comparison with the component layers.

Multi-layer polypropylene in which the layers are spaced apart by vertical walls is also known. Such a product is "Coroplast" ™ manufactured by porthole extrusion, i.e. a single extrusion die is actually configured to extrude a sheet having longitudinally extending, substantially square section, open ended channels.

For the sake of simplicity, multi-layer plastic sheeting have layers spaced apart by inner walls, will be referred to as "corrugated plastic sheet". This is intended as a comparison with "corrugated liner board" rather than as a strict definition. The term is used to include structures such as Coroplast ™ which is not strictly corrugated.

The top and bottom surfaces of the known corrugated plastic sheet tend to be not entirely flat due to differential cooling of the extrusion. Thus the top and bottom surfaces are at least usually slightly fluted along the lines of the interior walls. The surfaces are thin and comparatively fragile. It may be difficult to form coined lines for sharp bends, as for example right angled bends

between walls of cartons.

With the increased emphasis on recycling, it has been found desirable to provide a recyclable, insulating plastic corrugated sheet suitable for direct contact with food and being washable and sterilizable for reuse. The present applicant has addressed this problem.

DISCLOSURE OF THE INVENTION

According to the invention, there is provided a thermoplastic material sheet having internal parallel channels comprising two outer layers spaced apart by an inner structure comprising sloping walls, alternate walls sloping in opposing directions, to form the channels between opposing walls and at least one of the outer layers. The inner structure may comprise walls sloping at substantially 60° to each of the two outer layers and to each other, alternate opposing walls meeting at their edges through which they join a respective one of the outer layers.

Such a structure may be extruded by porthole extrusion, but if this technique is used, it is possible that a small amount of fluting will be present on the outer surfaces even though differential shrinkage between the layers may be minimized due to the even distribution of the mass of the inner structure between the outer layers. It is preferred that sheet according to the invention be produced by progressive extrusion to form a laminate of two outer layers sandwiching an inner structure. The progressive extrusion may involve the extrusion of separate layers for lamination for separate extruders. These layers are conveniently laminated in a vertical fall utilizing any or all of heating, pressure and chill rollers. Of course it is also possible to laminate preformed sheets or extruded layers with one or more preformed sheets.

Progressive lamination may be regarded as the

simultaneous extrusion of the outer layers and the inner structure through three separate extrusion nozzles. The two outer layers and the inner structure are quickly brought into contact while the extrusion is still unset to form the laminate.

The inner structure may be any suitable structure in which the mass of the structure is substantially evenly distributed between the outer layers. Suitable inner structures may comprise corrugated extrusions having ridges and troughs of V-shape, e.g. having an angle of 60°, or of undulating form, e.g. of sinusoidal form.

The inner structure holds the outer layers apart and provides parallel channels between them. The channels have triangular cross section for an inner structure of V-shaped corrugation and have a curved side and a straight side for an inner structure of generally sinusoidal form.

The channels may be closed at their ends by, for example, pinching together the outer layers such that the inner structure is collapsed to an end mass of substantially even distribution between the outer layers. If it is desired to seal the channel ends in addition to closing them, the pinched together ends may be heat sealed, e.g. by ultrasonic welding.

A somewhat similar technique may be used to provide flattened panels in a sheet of corrugated plastics sheet according to the invention, in this case, panel areas are pinched together to collapse the inner structure to a panel mass of substantially even distribution between the outer layers, and the outer layers and substantially evenly distributed panel mass are heat sealed together, e.g. by ultrasonic welding. Such panel areas are useful as "plates" in food cartons such as pizza boxes or may be used for tabs of erectable carton blanks.

Similarly, coining may be provided by pinching together the outer layers to collapse the inner structure to form a line mass of substantially even distribution between the outer layers. These coined lines may be heat sealed if desired.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described by way of example with reference to the drawings, in which:

Figure 1 is a cross section of one example of prior art thermoplastics sheet;

Figure 2 is a cross section of the sheet of Figure 1 showing buckling of interior walls when outer layers are pinched together;

Figure 3 is a cross section of one sheet according to the invention;

Figure 4 is a cross section of the sheet of Figure 1 after pinching the outer layers together and sealing them;

Figure 5 is a cross section through another sheet according to the invention;

Figure 6 is a sketch showing a sheet of the invention having a sealed end, a sealed panel and a coined line;

Figure 7 shows a pizza box formed from sheet material of the invention; and,

Figure 8 shows a sketch of the sequence of process steps in one possible process of making a sheet according to the invention.

MODES OF CARRYING OUT THE INVENTION

The example of prior art sheet material 10 shown in Figures 1 and 2 of the drawings may usually be formed of polypropylene and produced by porthole extrusion.

Thus, the prior art sheet 10 which has adjacent

elongate channels 16 of substantially square cross section may be produced by extrusion through a single extrusion nozzle configured to have an outlet comprising a pair of elongate, horizontal, parallel slots for extruding the outer layers 12 of the sheet. The slots are connected by short, vertical, parallel slots for extruding the inner walls 14. The resulting extrusion shrinks as it cools so that the outer layers 12 are not entirely flat but have elongate grooves 13 extending along the line of each interior wall 14. Thus, the upper and lower surfaces of the sheet may be slightly fluted.

This prior art sheet has considerable advantages for use in place of corrugated liner board for many applications. It is, however, not very suitable for reuse applications where it has direct contact with food. The fluted surface is not so easy to clean as a flat surface, the ends of channels 16 are open to the ingress of dirt, bacteria and viruses and, importantly, the surface is quite fragile and easily penetrated by a knife or fork or other sharp edge or point. Difficulties also arise in bending this prior art material about a sharp fold line. When the layers 12 are squeezed together, walls 14 may tend to buckle each into a separate crumbled mass resisting further squeezing together of layers 12 and making sealing together of layers 12 either difficult or impossible. Thus it may be seen that attempts to coin a fold line or to bring edges of the sheet together to close the mouths of channel 16 or squeeze the inner and outer layers together for other purposes, may result in a structure as shown in the sketch of Figure 2.

Figures 3 and 5 show cross sections of sheets according to the invention in which the inner structure is distributed over space between outer layers 32 (Figure 3) or 42 (Figure 5).

To avoid the problem presented by fluted upper

and lower surfaces, sheet according to the invention may be made by progressive extrusion, i.e. two separate elongate extrusion slots are provided, each being for the extrusion of one of the upper or lower layers 32, 42. A further slot of saw tooth or waved configuration is provided for extrusion of the inner structure. Upon extrusion, the outer layers 32, 42 are contacted with ridges or troughs of walls 34, or 44 of the inner structure to bond the laminated outer layers and the inner structure together.

The inner structure may comprise walls 34 each sloped at substantially 60° to the outer layers 32, alternate walls sloping in opposite directions and meeting at ridges and troughs respectively coincident with the upper and lower layers 32. In this case (Figure 3), the bulk of the walls 34 is distributed with respect to the area of layers 32. If the layers 32 are squeezed together, the walls 32 will tend to crumple in an inner layer distributed evenly between outer layers 32. Discrete separate masses of crumpled inner walls such as described in relation to Figure 2 should not occur. As a result, it may be possible to squeeze layers 32 more closely together than was possible for prior art structures. The structures produced by squeezing the layers 32 closely together may approach the structure shown in Figure 4 in which collapsed walls 34 are shown as a single inner layer 38. In fact, the integral layer 38 may only be actually formed after heat sealing, e.g. by ultrasonic welding. Nevertheless, even before sealing, the close proximity of layers 32 after pinching them together, may allow the forming of coining 52 (Figure 6) for improved folding of the sheet at a sharp bend. Such coining 52 may, if desired, be additionally heat sealed.

Figure 5 shows a cross section of another embodiment of the invention. As described in relation to Figures 3 and 4, the inner structure between the outer layers 42 of the sheet of Figure 5 is distributed over the

region between layers 42. In this case, however, sloping walls 44 provided by an undulating inner sheet which may be of sinusoidal form. The ridges and troughs are smoothly curved and sloping walls 44 merge the one within the other. Channels 46 have a cross section with one straight edge and a curved edge. On squeezing, pinching or pressing together, a sheet having substantially the structure of that shown in Figure 4 may be obtained.

Figure 6 shows a detail of a sheet according to the invention having an edge 56 in with the outer layers been pressed together and sealed to close the mouths of channels within the structure. A panel 54 also provided. the panel 54 has no channels in the thickness of the sheet but may be provided by pressing together the outer layers so that the inner structure is evenly distributed between thin and heat sealing the layers of the panel.

Figure 7 shows one embodiment of an improved carton suitable for use in direct contact with food and which may be recyclable. Suitable thermoplastics material from which the sheet and the carton 60 may be made is polyethylene but any food grade thermoplastic material may be used especially those suitable for recycling.

Carton 60 may be a pizza box formed of thermoplastics material sheet according to the invention. The sheet should be sufficiently rigid to retain the carton shape. To an extent, the channel structure of the sheet provides rigidity to sheet of which the thickness of individual layers and inner structure might otherwise be insufficient to be self-supporting. It may be seen, therefore, that cartons may be constructed with less total bulk of plastic material then has hitherto been possible. The reduction in mass that may be possible is envisaged to be in the region of 40% to 60%. The degree of rigidity required is a function of the particular carton and the degree of strength and durability required is a function of

the envisaged amount of reusage. These characteristics are a matter of choice within the general scope of the invention.

For a pizza box, for example, a pizza box as shown in Figure 7, it may be desirable to incorporate a panel of greater surface toughness against the effects of pronged or sharp edged instruments. Thus panel 54 may be provided in any desired shape by crushing or pressing outer layers 32 of the sheet together over the desired area. That area may then be subjected to heat, for example, by ultrasonic welding, to form a laminated flattened panel 54. The inner layer of panel 54 comprises collapsed walls of the inner structure of the sheet which have, on crushing, collapsed relatively evenly between outer layers 32. These collapsed walls form an integral inner layer on heat sealing. It may be that ultrasonic welding plates may also be utilized to initially press layers 12 together. The edges of the pizza box which are adjacent longitudinal walls of channels of the sheet material are sealed against the ingress of dirt and germs. The edges to which section the channels must be sealed by provision of a sealing edge such as sealing edge 56.

To guard against ingress of dirt and germs into channels 36, 46 the ends of the channels may be sealed. Thus layers 32, 42, at open ends of channels 36, 46, may be pressed together and heat sealed. Such a closed, sealed edge is shown at 56 in Figure 6.

Other embodiments are possible within the spirit of the invention. In particular, it may be possible to provide a steel structure comprising more than two layers 32, 42 each pair of layers having an inner structure there between.

Figure 8 shows one example of process steps which may be used. Corrugated sheet is either preformed or

extruded from extruder 62. In any event it may be allowed to fall vertically. Outer laminating sheets 64, are provided either pre-formed or from extruders 66 and allowed to fall vertically to either side of sheet 60. The three sheets 64, 60, 64 may pass guide rollers 67 and then between heating rollers 68. These are of importance when pre-formed sheet is used. Then sheets then pass between pressure rollers 70 which laminate them together. Thereafter they may pass through chill rollers 72 and possibly transport conveyor 74. Other transport rollers may additional be used.

CLAIMS

1. Thermoplastics material sheet having a longitudinal dimension and a transverse direction and formed by having internal extending in a longitudinal direction comprising two parallel outer layers spaced apart by an inner structure comprising elongate sloping walls extending in the longitudinal direction of the sheet, alternate elongate walls sloping in opposing directions to form elongate channels between opposing elongate walls and at least one of the outer layers.

2. Thermoplastic sheet material as claimed in Claim 1 in which the inner structure comprises walls sloping at substantially 60° to each of the two outer layers, alternate opposing walls meeting at their edges through which they join a respective one of the outer layers.

3. Thermoplastic sheet material as claimed in Claim 1 comprising a laminate of two outer layers sandwiching the inner structure.

4. Thermoplastic sheet material as claimed in Claim 3 in which the laminate if formed by lamination of unset extrusions of the outer layers and inner structure.

5. Thermoplastic sheet material as claimed in Claim 4 in which the inner structure comprises a corrugated extrusion having ridges and troughs of V-shape.

6. Thermoplastic sheet material as claimed in Claim 5 in which the angle of each V-shaped ridge and trough is substantially 60°.

7. Thermoplastic sheet material as claimed n Claim 4 in which the inner structure comprises a corrugated extrusion having undulating ridges and troughs.

8. Thermoplastic sheet material as claimed in Claim 7 in which the undulating corrugated extrusion is of sinusoidal form.

9. Thermoplastic sheet material as claimed in Claim 1 in which ends of the channels are closed.

10. Thermoplastic sheet material as claimed in Claim 9 in which ends of the channels are pinched together such that the inner structure is collapsed to an end mass of substantially even distribution between the outer layers.

11. Thermoplastic sheet material as claimed in Claim 10 in which the outer layers and substantially distributed collapsed inner structure are sealed together.

12. Thermoplastic sheet material as claimed in Claim 1 in which panels comprise areas in which the inner structure is collapsed to a panel mass of substantially even distribution between the outer layers, and the outer layers and substantially evenly distributed panel mass are sealed together.

13. Thermoplastic sheet material as claimed in Claim 1 having coined lines along which the sheet is bendable, the coined lines comprising lines along which the inner structure is collapsed to form a line mass of substantially even distribution between the outer layers.

14. Thermoplastic sheet material as claimed in Claim 1 in which the thermoplastic material is polyethylene.

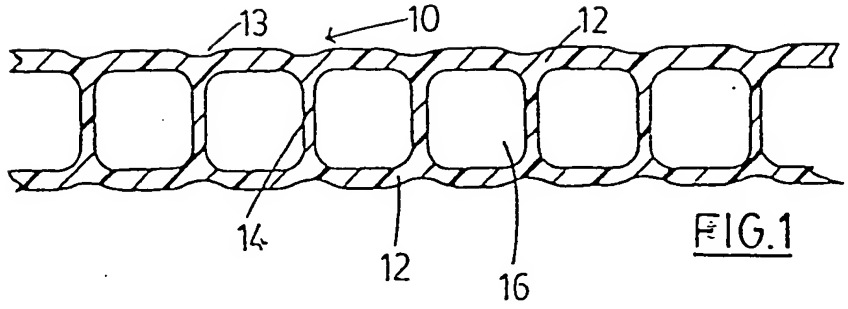


FIG.1

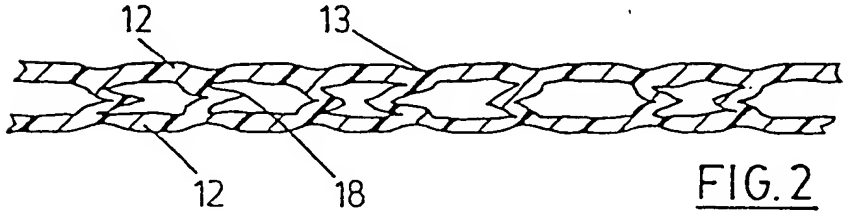


FIG. 2

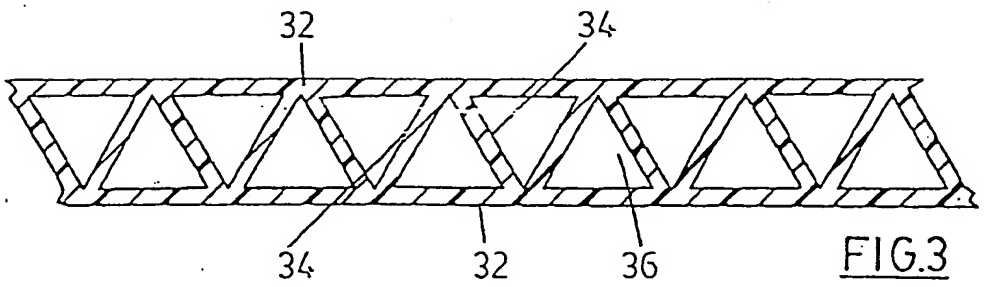


FIG.3

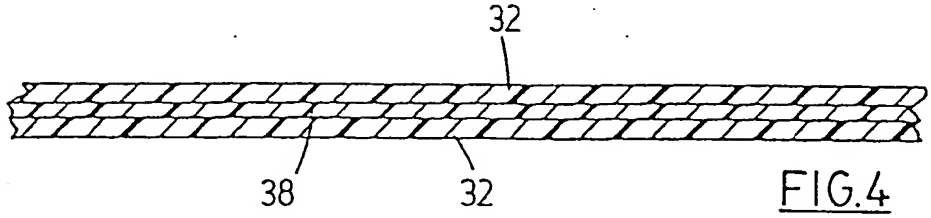


FIG.4

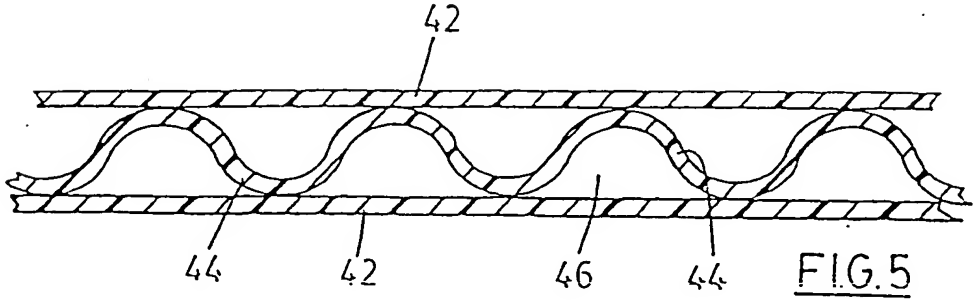
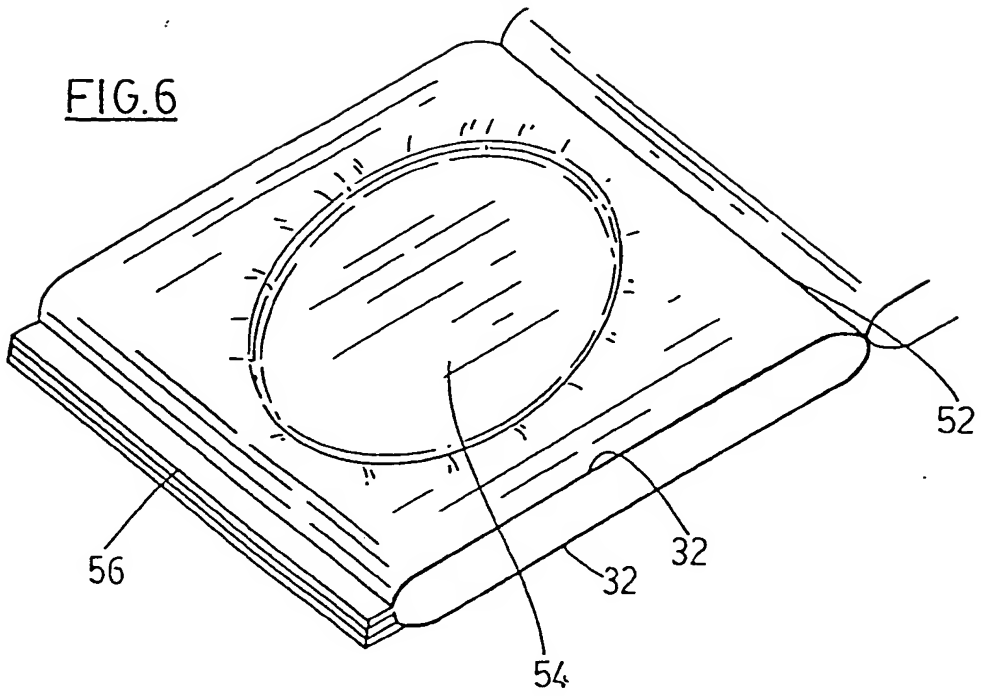


FIG.5

FIG.6



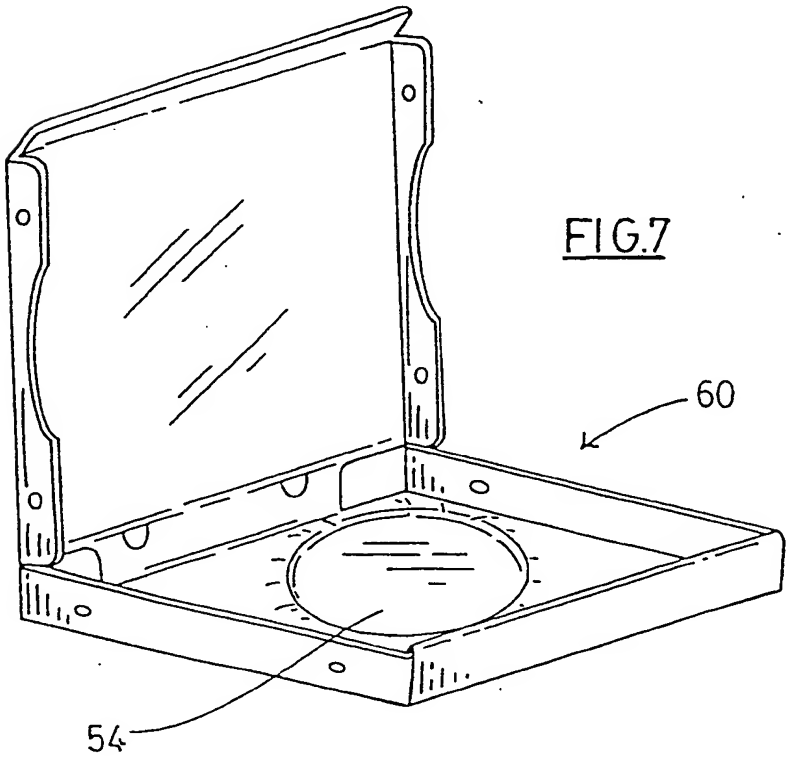


FIG.7

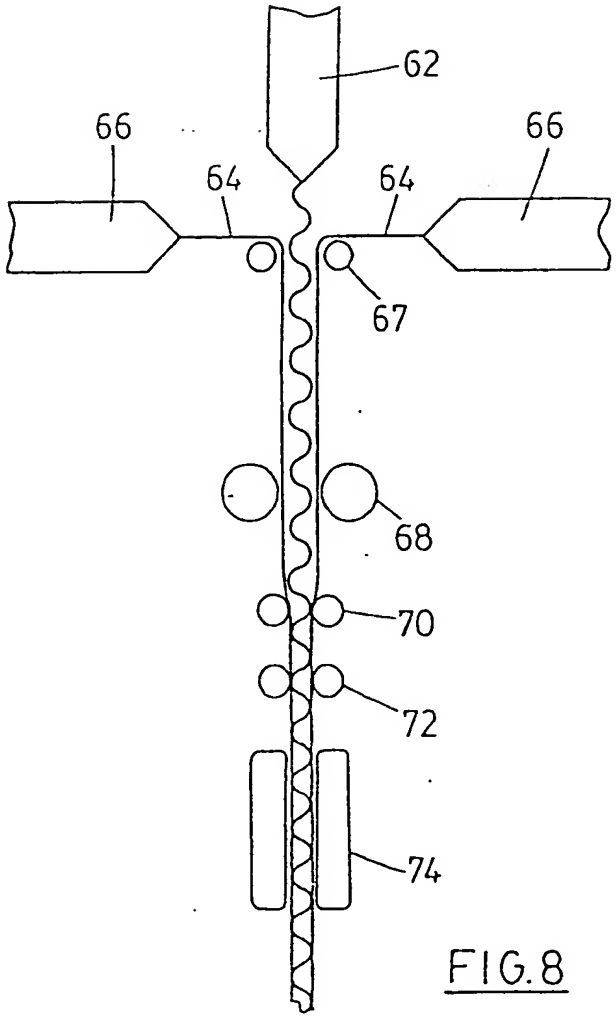


FIG.8

INTERNATIONAL SEARCH REPORT

International Application No PCT/CA 92/00385

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B32B3/28; B32B27/08

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B32B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category[10]	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	US,A,4 132 581 (SWARTZ) 2 January 1979 see column 9, line 62 - column 10, line 20; claims 1-9; figures 1,5,9,15 see column 10, line 51 - column 11, line 42; figure 11	1-8,14
X A	US,A,3 723 222 (KURITA ET AL.) 27 March 1973 see column 1, line 39 - column 4, line 32; claim 1; figures 1,2,3A-C see column 5, line 57 - column 7, line 22	1-4,7,8,14 5,6
X A	US,A,4 507 348 (NAGATA ET AL.) 26 March 1985 see column 1, line 41 - line 54; claims 1,2,5-7; figures 1-3,6,10 see column 2, line 5 - line 30 see column 2, line 50 - column 3, line 44	1-3,5,7,8,13,14 5,10-12

-/--

[10] Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
30 MARCH 1993	22. 04. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	DERZ T.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	US,A,3 900 356 (KOCH ET AL.) 19 August 1975	1,9-12, 14
A	see column 1, line 43 - column 2, line 20; claims 1,2; figures 1,3,5 see column 2, line 42 - line 64 see column 4, line 30 - line 42	5,6
X	GB,A,1 308 867 (MITSUBISHI PETROCHEMICAL COMPANY LTD.) 7 March 1973	1,3,4,7, 8,14
A	see page 2, line 56 - line 90; claims 1,2,4,6,9; figures 1,2 see page 2, line 110 - page 3, line 35	5,6
X	FR,A,2 468 065 (MONTEDISON SPA) 30 April 1981 see page 2, line 28 - page 4, line 4; claim 1; figures 1-3 see page 4, line 21 - line 36	1-3,5,6
X	EP,A,0 085 534 (THE BRITISH PETROLEUM COMPANY P.L.C.) 10 August 1983	1,14
A	see page 3, line 2 - line 7; claims 1,2,5,8	9

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

CA 9200385
SA 64428

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 30/03/93

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-4132581	02-01-79	US-A- 4188253	12-02-80
US-A-3723222	27-03-73	None	
US-A-4507348	26-03-85	JP-A- 57046743	17-03-82
US-A-3900356	19-08-75	None	
GB-A-1308867	07-03-73	US-A- 3816204	11-06-74
FR-A-2468065	30-04-81	BE-A- 885775	17-04-81
		GB-A,B 2061354	13-05-81
		NL-A- 8005654	22-04-81
EP-A-0085534	10-08-83	None	

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82